PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : F42B 3/22, 3/087, F42D 1/20, 1/22, 3/04 — A1

(11) International Publication Number: WO 00/60301

(43) International Publication Date: 12 October 2000 (12.10.00)

(21) International Application Number: PCT/AU00/00265

(22) International Filing Date: 30 March 2000 (30.03.00)

(30) Priority Data:

60/127,463	31 March 1999 (31.03.99)	US
60/173,182	27 December 1999 (27.12.99)	US
60/175,063	7 January 2000 (07.01.00)	US

(71) Applicant *(for all designated States except US)*: ROCKTEK LTD. [AU/AU]; Lot 333 Harries Way, Pinjarra, W.A. 6208 (AU).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: GAVRILOVIC, Mihailo [AU/US]; 3272 S. Leyden Street, Denver, CO 80222 (US). MICKE, Brian [US/US]; 22910 Pinecrest Road, Golden, CO 80401 (US).

(74) Agent: MIZZI, Anthony, Paul; Griffith Hack, Level 6, 256 Adelaide Terrace, Perth, W.A. 6000 (AU).

(81) Designated States: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

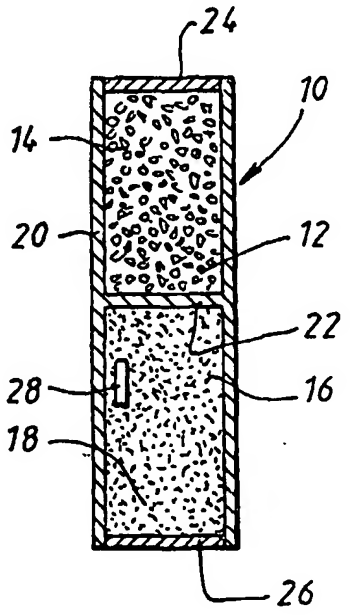
Published

With international search report.

(54) Title: CARTRIDGE AND CHARGING SYSTEM INCORPORATING SAME

(57) Abstract

Cartridge (10) includes first compartment (12) for holding a volume of energy absorbing stemming material (14) and adjacent second compartment (16) for holding a volume of energetic explosive or propellant material (18). Initiator (28) is disposed in compartment (16). Dividing wall (22) separates compartments (12, 16) and may be conical in shape so as to deform and seal the borehole upon detonation of material (18). Cartridge (10) may be integrally formed or assembled from two separate containers coupled together. Compartment (12) can be made from thin-walled material including one or more slits or lines of weakness to facilitate deformation or bursting. Cartridge (10) can be secured to a stemming bar for placement in the borehole. Charging systems and methods of charging a hole formed in hard material are also described and claimed.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

CARTRIDGE AND CHARGING SYSTEM INCORPORATING SAME

Field of the Invention

The present invention relates to a cartridge and associated charging system, particularly for charging a hole in a hard material for the purpose of fracturing the hard material.

Background of the Invention

One known way of fracturing or excavating hard material such as rock is the drill and blast method. This involves drilling a hole in the hard material and charging the hole with a quantity of energetic material and preferably some type of stemming. In its most basic form this involves depositing a quantity of energetic material into the bottom of the hole, filling the remainder of the hole with a stemming material such as drill cuttings or aggregate and then initiating the energetic material causing a rapid increase of gas pressure at the bottom of the hole for fracturing the hard material. Often this is accompanied by the ejection of a quantity of the stemming material from the hole.

The energetic material is typically supplied either as loose bulk material or packaged as a cartridge. The cartridge form is commonly used for small charge blasting and usually also includes an initiator. Stemming material is most usually available as a loose bulk material but can also be supplied in packages. The energetic material and stemming material are purchased, delivered, stored and used separately. Similarly they are loaded separately into the hole by different machines.

For commercial reasons it is important that the fracturing of hard material whether it be for mining or for civil excavation be accomplished as quickly as possible. Additional substantial commercial benefits can be obtained if charging of the hole can be accomplished with minimal handling of materials and use of equipment of low capital cost. For safety reasons it is also preferable if there is no, or at most only minimal ejection of low velocity stemming from the hole.

Summary of the Invention

It is an object of the present invention to provide a simple cartridge and associated charging system that is easy to use, requires minimal materials handling, and does not require the use of costly specialised machines for charging.

According to one form of the invention there is provided a cartridge having a first compartment holding a volume of stemming material and a second compartment holding a volume of energetic material.

Preferably the cartridge includes a cartridge shell having a dividing wall to form, on opposite sides thereof, the first and second compartments.

Preferably the cartridge shell includes a first container defining said first compartment and a second container defining said second compartment, and the first and second containers are joined end to end to form the cartridge, with said dividing wall provided between said first and second compartment.

Preferably the first container has opposite first and second ends and the second container has opposite first and second ends and the second end of the first container and the first end of the second container are provided with respective complementary releasable engaging means for joining the first and second containers together.

In one embodiment, the dividing wall is in the form of a first plug inserted into an end of the second compartment adjacent the first compartment.

In a second embodiment, the dividing wall is in the form of a wall formed integrally with an end of the second compartment adjacent the first compartment.

In a third embodiment, the dividing wall is part of a coupling device that couples the first compartment to the second compartment.

Preferably, the dividing wall is in the shape of a cone that converges in a direction from the first compartment to the second compartment.

Preferably the cone includes a lateral flange extending radially outwardly about a base of the cone and between the first and second compartments whereby, in use, upon initiation of the energetic material, the cone is deformed in a manner to spread the flange into abutting contact with the sides of the hole for resisting the escape of gases generated by the energetic material from above the second compartment.

Preferably the cartridge further includes wedging means coupled to the first compartment to wedge between an outer peripheral surface of the first compartment and the side wall of the hole to form a seal in the hole.

Preferably said wedging means includes a wedging cap that fits over said a free end of the first compartment, the cap having a tapered skirt that increases in thickness in a direction away from the second compartment.

Preferably a free end of the first compartment is provided with an end cap having a tapered external surface for mating with and assist in outward spreading of said wedging cap when said wedging cap is pushed onto said end cap.

Preferably the cartridge further includes a passage passing through the first compartment to provide communication between the second compartment and a location remote from the cartridge.

Preferably the cartridge further includes an initiator disposed in the second compartment for initiating the energetic material.

Preferably the cartridge further includes an initiator cord or lead passing through the passage and connected at one end to the initiator and having a free opposite end for

connection to an initiation source.

According to a further form of the invention there is provided a charging system for charging a hole formed in a hard material, the system including:

a cartridge having a first compartment holding a volume of stemming material and a second compartment holding a volume of energetic material; and

a stemming bar having a lower end engaging the cartridge when in the hole and an upper end adjacent or extending from the hole.

Preferably in the charging system the cartridge includes a coupling means for coupling the stemmed cartridge to the lower end of the stemming bar.

Preferably the coupling means includes a recess of a shape complimentary to the shape of the lower end of the stemming bar for receiving the lower end of the stemming bar with an interference fit.

According to another aspect of the invention there is provided a method of charging a hole including the steps of:

providing a cartridge having a first compartment holding a volume of stemming material and a second compartment holding a volume of energetic material;

inserting the cartridge, with the second compartment first, into a hole formed in a hard material to be fractured; and

inserting a stemming bar into the hole with a lower end of the stemming bar bearing on said cartridge.

Preferably the method further includes coupling the cartridge to the lower end of the stemming bar and inserting the stemming bar, lower end first, into the hole.

Preferably the method further includes a step of mechanically holding the stemming bar in the hole.

Preferably said step of mechanically holding the stemming bar involves placing a massive object against an upper end of the stemming bar extending from the hole.

Preferably the method further includes the step of applying a compressive force to the first compartment to radially expand the first compartment into contact with a peripheral surface of the hole.

Preferably the step of applying a compressive force comprises applying a force to the upper end of the stemming bar which force is transmitted by the stemming bar to the first compartment.

Brief Description of the Drawings

The embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is a schematic representation of a first embodiment of the cartridge;

Figure 2 is a schematic representation of a charging system incorporating a second embodiment of the cartridge;

Figure 3 is a partially exploded view of the charging system incorporating a third embodiment of the cartridge;

Figure 4 is a top view of a first container of the third embodiment of the ridge;

Figure 5 is a side view of the first container shown in Figure 4;

Figure 6 is a plan view of an end cap for the first container;

Figure 7 is a top view of a second container used in the third embodiment of the stemmed cartridge;

Figure 8 is a side view of the second container shown in Figure 7;

Figure 9 is a plan view of an end plate for the second container;

Figure 10 is a view of section A-A used of the stemming bar used in the charging system depicted in Figure 3;

Figure 11 is a sectional view of a fourth embodiment of the cartridge;

Figure 12 is a sectional view of a fifth embodiment of the cartridge;

Figure 13 is a sectional view of a sixth embodiment of the cartridge;

Figure 14 is a sectional view of a seventh embodiment of the cartridge; and
Figure 15 is a sectional view of an eighth embodiment of the cartridge.

Detailed Description of the Preferred Embodiments

Figure 1 depicts the simplest form of the cartridge and associated charging system. The cartridge 10 has a first compartment 12 for holding a volume of stemming material 14 such as gravel and a second compartment 16 for holding an energetic material 18. The stemming material acts to absorb as well as redirect or deflect blast energy. The term "energetic material" is intended to denote an explosive, a propellant, or a combination thereof. In its most basic form the stemming cartridge 10 includes a cylindrical shell 20 having an internal dividing wall 22 which forms, on its opposite sides, the first and second compartments 12 and 16. A first end wall 24 is provided for closing off the compartment 12 and a second end wall 26 is provided for closing off the second compartment 16. An initiator 28 is provided in the second compartment 16 for initiating the energetic material 18. In this embodiment the initiator 28 can be activated by radio waves.

In use, the cartridge 10 is placed at the toe of a hole formed in a hard material to be fractured, with the second compartment 16 first or lowermost. If the cartridge 10 does not fall to the toe (bottom) of the hole on its own accord it can be pushed to the bottom of the hole by use of a conventional stemming bar of uniform cross-sectional shape. The combination of the stemmed cartridge 10 and the stemming bar forms a charging system for charging the hole in the hard material. In this system, as explained in greater detail with reference to Figures 3-10 a lower end of the stemming bar engages a free end of the first compartment (ie the upper end of the cartridge 10). This can be simply by way of end to end face contact.

Figure 2 depicts a second embodiment of the cartridge 10A and a charging system 30 incorporating the cartridge 10A. The cartridge 10A is in essence the same as the cartridge 10 depicted in Figure 1 with the only substantive difference being an extension 32 of the shell 20 beyond the wall 24 to define a recess 34. Recess 34 receives lower end 36 of a stemming bar 38. The fit between recess 34 and 36 is snug so that the cartridge 10 is self-

supporting on the stemming bar 38. The combination of the stemming bar 38 and the cartridge 10A forms the charging system 30. The stemming bar 38 is provided with a longitudinally extending slot, recess or channel 40 through which an initiator cord 42 passes. The cord 42 is coupled at one end to the initiator 28 and at an opposite end to an initiation source (not shown).

In this embodiment, the cartridge 10A is pushed onto the stemming bar 38 with the lower end 36 of the stemming bar received within the recess 34 and abutting the wall 24. The assembly of the stemming bar 38 and cartridge 10A is then inserted into a hole 44 in a rock 46 (or other hard material to be fractured). The cartridges 10, 10A as depicted in Figures 1 and 2 are formed from a unitary shell 20, except for the end walls 24 and 26. Notwithstanding this, it is possible for a portion of the shell 20 that defines the first compartment 12 to have a wall thickness than that of the first compartment 16. This can allow the first compartment 12 to expand radially outwardly by the application of a compressive force that can be supplied by applying a downward pushing force on a stemming bar abutting the end wall 24. By radially expanding the first compartment 12, the sealing of the hole 44 can be enhanced thereby improving blasting efficiency. This also enables the stemming material 14 to redirect or deflect a portion of the blast energy to the wall of the hole 44, away from the stemming bar.

A third embodiment of the cartridge 10B and charging system 30B is shown in Figures 3-10. Here the first compartment 12 of cartridge 10B is defined by a first container 48 for holding the energy absorbing stemming material 14 and the second compartment 16 is defined by a second container 50 for holding the energetic material 18. The containers 48 and 50 are joined end to end. This is achieved by providing the first container 48 with a coupling in the form of an internal recess 52 at its lower end 54 for engaging with a coupling in the form of a boss 56 provided at an upper end 58 of the second container 50.

As shown in Figure 3, by push fitting the boss 50 into the recess 52 the first and second containers 48 and 50 are releasably attached or joined together to form the cartridge 10B. When in use the cartridge 10B is lowered into a hole 44 formed in a hard material such as

a boulder or rock 46 with the second container 50 first or lower most thereby charging the hole 44 with both stemming material 14 and energetic material 18.

The first container 48 is in the form of a cylindrical tube having an internal conical wall 60 near its upper end 62. The conical wall 60 commences from a location below the upper end 62 and is orientated to point toward the second container 50. Extending longitudinally within the cylindrical body of the first container 48 is an internal passage 64. The passage commences at the upper end 64 of the container 48 and extends to its lowest point 66 spaced above the lower end 54. The passage 64 also extends through the conical wall 60. The conical wall 60 effectively closes the upper end 62 of container 48 and can be equated with end wall 24 of cartridges 10 and 10A shown in Figures 1 and 2. That is conical wall 60 can be viewed as one of many different configurations of end walls for the first compartment 12. In order to close the lower end 54 a closing plate 68 is provided in the form of a disc. This plate 68 is formed with an arcuate cut-out 70 that fits over the passage 64. One or more internal lands 72 are or can be provided on the inner circumferential surface of the container 48 slightly above the lowest point 66 for seating the plate 68.

During manufacture of the cartridge 10B the first container 48 would initially be inverted and filled from its lower end 52 with the stemming material 14. The end plate 68 is inserted into the lower end 52 to rest on the lands 72 with the cut-out 70 seated over the end of the passage 64. The end plate 42 can be glued, welded or otherwise fixed in place.

The second container 50 is also in the form of a short cylindrical tube with an integral end wall 74 extending across its upper end 58. The boss 56 is created by forming a circumferential shoulder 76 about the container 50 at a location below its upper end 58. The end wall 74 is provided with a hole 78 leading into the second compartment 16. Lower end 80 of the second container 50 is closed by an end wall in the form of disc 82 fitted inside the lower end 54 and glued, welded or otherwise fixed in place. However, prior to fixing the end wall 82 in place, the second container 50 is filled with the energetic material 18. Additionally the initiator 28 is inserted into the container 50.

The end plate 68 and boss 56 either taken separately or in combination act as a dividing wall akin to wall 22 in the cartridges 10, 10A of Figures 1 and 2, separating the stemming material 14 and the energetic material 18. Additionally, end wall or disc 82 acts and functions in the same way as wall 26 of cartridges 10, 10A.

In this embodiment the initiator 28 is of the type that requires physical connection with an initiation source via some type of cord or lead 42. The cord or lead 42 passes through the hole 78 in the boss 56. Further, when assembling the first and second containers 48 and 50, the lead 42 is also passed through the passage 64 from the lower end 54 up through the upper end 62 of the first container 48.

As depicted in Figure 3, the associated charging system 30B includes elongated stemming bar 38 having a conically tapered lower end 36B of a shape complementary to that of the conical wall 60 for seating inside the upper end 62 of the first container 48. In this way, the cartridge 10B can be physically held on the lower end 36B of the stemming bar 38. Therefore if required, or if convenient, the cartridge 10B can be simply pushed onto the stemming bar 38 and the stemming bar inserted into the hole 44 thereby simultaneously charging the hole with energetic material 18, and stemming the hole with both the stemming material 14 and the stemming bar 38 itself. To allow connection of the initiator 28 with an initiation source, the stemming bar 38 is provided with the longitudinally extending slot 40 through which the cord 42 can be passed. In order to retain the cord 42 within the confines of the stemming bar 38 a series of transversely extending pins 84 (refer to Figure 10) are passed through the stemming bar 38 across the slot 40.

In use, the stemming bar 38 can also be mechanically held in place, for example by holding or pushing its upper end with the use of a massive object such as a jumbo, excavator bucket or bulldozer bucket, or alternately by use of other mechanical means such as wedges or jacks. Further, a compressive force can be applied to the first container 48 by the stemming bar 38 by using the aforementioned massive object to radially expand the first container 48 into physical contact with the side walls of the holes 44. To assist

in this radial expansion, the cartridge 10B (or cartridges 10, 10A) can also be formed with longitudinal lines of weakness. As mentioned previously this pre-loading of the cartridge 10B to effectively expand the stemming material in contact with the hole 44 assists in deflecting or redirecting some of the blast energy into the material itself, away from the stemming bar, thus also reducing recoil.

In embodiments where the initiator 28 is operated via electromagnetic/magnetic waves or fields a radio transmitter is situated in or near the lower end of the stemming bar 38. Further, to assist in the conduction of electromagnetic/magnetic waves and fields the stemming material 14 may be made of a material that conducts such fields or waves or alternately the stemming material 14 can be doped with particles that assist in the conduction of electromagnetic or magnetic waves and fields.

In a further variation, additional containers similar to the second containers 50 (hereinafter referred to as third containers) can be provided with energetic material only to act as booster cartridges. Such booster cartridges could be releasably connectable to the lower end 80 of the second containers 50. This can be achieved in a similar manner to that in which the second containers 50 is made releasably connectable to the first container 48. Alternately one or more booster cartridges could be placed first in the hole 44 and pushed to the bottom by insertion of the cartridge 10B and/or stemming bar 38 into the hole.

Also additional separate containers or cartridges holding stemming only can be provided for end to end engagement with the upper end of the cartridge 10, 10A, 10B between the stemming bar 38 and the cartridge. These additional containers or cartridges can be made releasably connectable in an end to end manner.

Figure 11 depicts a further embodiment of the cartridge 10C. The cartridge 10C comprises a first container 48 defining the first compartment 12 for holding stemming material 16 and a second container 50 defining the second compartment 16 for holding the energetic material 18. Dividing wall 22 between the first and second compartments is in the form of a plug having an axial hole through which lead 42 of initiator 28 passes. The

initiator 28 is disposed within the second container 50. The free end of the second container 50 is closed by a wall 26 which is also in the form of a plug. The opposite end of the cartridge 10C is closed with an end wall 24 through which the lead 42 passes. In order to increase the sealing/stemming effect, the first compartment 12 ie. container 48 is constructed to be deformable when pressure is applied to the end wall 24 of the cartridge 10C when in the hole. Such pressure may be applied by manual tamping or packing using a rod. The pressure results in the compartment 12 expanding radially outwardly against the wall of a hole. This can provide sufficient grip so as to hold the cartridge 10C within the hole without being ejected upon detonation, without the need of any external device such as a stemming bar. In such instances, the cartridge 10C acts as a self-stemming cartridge. It is envisaged that this effect will be most apparent with small diameter holes say of up to 18mm.

Lines or slits of weakness can be formed about the compartment 12 in order to enhance its deformation and increase the likelihood of it bursting upon the application of a compressive force on end wall 24. The deformation and bursting can be further enhanced by making the compartment 12/container 48 from an easily deformable material such as thin wall plastics or paper.

The first compartment 16/container 50 is in the form of an open ended tube made from a rigid material that would resist deformation during the tamping or application of compressive force on the end 24 of the cartridge 10C. For example the compartment 16 may be made from rigid plastics, metal or a composite. The compartment 16/container 50 should be rigid and relatively strong to allow a high rate of pressure development of the ignited energetic material 18. This may be advantageous because a very rapid rise of pressure leads in turn to a very rapid complete combustion reaction of the energetic material 18. The faster this reaction, the less change of gas leakage prior to use for work being done in terms of breaking or fracturing the rock or other hard material.

Figure 12 depicts a further embodiment of the cartridge 10D. The cartridge 10D differs from cartridge 10C solely in the form of the dividing wall 22 between the first

compartment 12 and second compartment 16. In this embodiment, the dividing wall 22 is formed integrally with end 58 of the second container 50. In all other respects, the cartridge 10D is the same as cartridge 10C depicted in Figure 11.

Figure 13 depicts a further embodiment of the cartridge 10E that is identical to the cartridge 10C of Figure 11 but with the additional of a wedging means in the form of a wedging cap 86 coupled to the free end of the first compartment 12. In use, the wedging cap 86 acts to wedge between the outer peripheral surface of the cartridge 10E and the side wall of the hole. This produces two effects. Firstly, it assists in sealing the hole. Further, it serves to retain the cartridge 10E in the hole during and after detonation so as to enhance the self-stemming effect of the cartridge 10E. The cap 86 is provided with a central hole through which the lead 42 passes. The wall or skirt 88 that is tapered so as to increase in thickness in a direction away from the second compartment 16. When the cartridge 10E is inserted into a hole pressure is applied thereto via the cap 86. This forces the cap 86 over the free end of the compartment 12 and, due to the tapered nature of the skirt 88 can cause skirt 88 to flare radially outwardly. The flaring of the skirt 88 can be enhanced by providing one or more longitudinally slots or castellations in a skirt 88.

A further embodiment of the cartridge 10F is depicted in Figure 14. The cartridge 10F differs from cartridge 10E depicted in Figure 3 only by the replacement of the planar end wall 24 with a frusto-conical cap 24F. The cap 24F has an upper frustum 90 that converges in a direction away from the first compartment 12. End 92 of the frustum 90 is provided with a hole through which the lead 42 extends. The opposite end of the cap 24F is provided with a short substantially constant diameter extension 94 that fits inside and is attached or otherwise fixed to the upper end 62 of the first compartment 12. The cap 24F mates with the ridging cap 86 to assist in wedging and locking the cap 86 against an inside surface of the hole into which the cartridge 10F is inserted.

Figure 15 depicts a further embodiment of the cartridge 10G. This embodiment includes a first compartment 12 for holding the energy absorbing stemming material 14 and a second compartment 16 for containing the energetic material 18. The cartridge 10G also includes

an end cap 24F and a wedging cap 86 similar to that of cartridge 10F depicted in Figure 14. The first compartment 12 is defined by a first container 48 and the second compartment defined by a second container 50. The cartridge 10G however differs from cartridge 10F as follows: the lower end 54 of the container 50 is closed by forming the compartment 50 with an integral closed lower end rather than by using a separate end wall or plug; and, the dividing wall 22 is in the form of a cone 96 that in turn constitutes part of a coupling 98 for coupling the first container 48 to the second container 50. The coupling 98 can be viewed as a short length of tube within which the cone 96 is located. The cone 96 is directed so that it converges in a direction from the first compartment 12 to the second compartment 16. A hole is formed at the apex of the cone 96 to allow passage of the lead 42. A lateral flange or ring 100 is formed about the base of the cone 96 on the outside of coupling 98. The flange 100 forms an abutment for the adjacent ends of the first and second compartments 48, 50.

It is envisaged that the coupling 98 will be moulded in one piece from a plastics material, although it could be made from several different components that are connected together, for example the cone 96 and the flange 100 as one component, and two short lengths of tubing that are co-linearly attached on opposite sides of the flange 100. The coupling 98 forms a number of functions including: acting as a pressure bulkhead during combustion of the energetic material 18; deforming in a manner so that the flange 100 extends radially outwardly to seal against the side walls of the hole during combustion of the energetic material 18 thus reducing the leakage of high pressure gases from the hole; forcing the stemming 14 in the region of the cone 96 upwardly into the container 48 thereby radially pressurising the stemming 14 against the internal surface of the first compartment 12 and thus in turn against the side walls of the hole thereby further assisting and reducing potential further leakage of high pressure gases from the hole; supporting and centralising the initiator 28; sealing the initiator 28 and energetic material 18 from moisture or other contaminants that may be present in the stemming 14; and supporting the first and second compartments 12, 16.

The cartridges 10 may be made in a variety of sizes, ie diameters. As mentioned above, the cartridges 10C - 10G have characteristics which enable them to be self-stemming in the hole particularly if used in smaller diameter holes say up to 18mm. The cartridges 10 would be ideally suited to independent contractors who have as their primary drilling device, small hand-held drills such as a HILTI or a KANGO hammer or a hand-held pneumatic impact hammer drill. As such types of manual drills are standard equipment for all blasting contractors, it can be appreciated that use of the present cartridge 10 does not require any capital outlay other than, of course, the cost of the cartridge 10 itself. Notwithstanding this, cartridges of larger diameter can be used for breaking or fracturing rock or other hard material in which larger diameter holes have been drilled by use of track mounted drills, jack leg drills or jumbo mounted drills. As the cartridge 10 includes all of the matter normally required, ie energetic material 16, stemming 18 and initiator 20 use of the cartridge 10 can simplify and increase the rate of blasting. There is no need to hold separate supplies of energetic material, stemming and initiators and then separately insert the same into a hole.

Now that embodiments of the present invention have been described in detail it will be apparent to those skilled in the relevant arts that numerous modifications and variations may be made without departing from the basic inventive concepts. For example, the stemming material 14 is largely depicted as being in the form of a particulate stemming such as aggregate. However other types of stemming can be included such as liquids or slurries that have the physical property of increasing viscosity with increased shear. Further, the upper end walls of the cartridges 10, 10A have been shown as being either a planar wall 24 or a conical wall 60. However this wall can take numerous other shapes such as concavely or convexly curved walls that can engage or mate with a complimentarily shaped lower end of the stemming bar. Also, there is no need for the portions of the cartridges 10, 10G that define the first and second compartments to be made from the same material. Ideally the second compartment holding the energetic material will have a reasonable degree of rigidity so as to confine the energetic material during the initial stages of initiation. On the other hand, it is preferable for the first

compartment containing the stemming material to be relatively easily radially deformable so that it can be pushed against the side walls of the hole to increase the sealing effect.

All such modifications and variations together with others that would be obvious to a person of obvious person skilled in the art are deemed to be within the scope of the present invention the nature of which is to be determined from the above description and the appended claims.

CLAIMS

1. A cartridge having a first compartment holding a volume of stemming material and a second compartment holding a volume of energetic material.

2. A cartridge according to claim 1 wherein the cartridge includes a cartridge shell having a dividing wall to form, on opposite sides thereof, the first and second compartments.

3. A cartridge according to claim 2 wherein the cartridge shell includes a first container defining said first compartment and a second container defining said second compartment, and the first and second containers are joined end to end to form the cartridge, with said dividing wall provided between said first and second compartment.

4. A cartridge according to claim 3 wherein the first container has opposite first and second ends and the second container has opposite first and second ends and the second end of the first container and the first end of the second container are provided with respective complementary releasable engaging means for joining the first and second containers together.

5. A cartridge according to claim 3 or 4 wherein the dividing wall is in the form of a first plug inserted into an end of the second compartment adjacent the first compartment.

6. A cartridge according to claim 3 or 4 wherein the dividing wall is in the form of a wall formed integrally with an end of the second compartment adjacent the first compartment.

7. A cartridge according to claim 2 or 3 wherein the dividing wall is part of a coupling device that couples the first compartment to the second compartment.

8. A cartridge according to claim 7 wherein the dividing wall is in the shape of a cone that converges in a direction from the first compartment to the second compartment.

9. A cartridge according to claim 8 wherein the cone includes a lateral flange extending radially outwardly about a base of the cone and between the first and second compartments whereby, in use, upon initiation of the energetic material, the cone is deformed in a manner to spread the flange into abutting contact with the sides of the hole for resisting the escape of gases generated by the energetic material from above the second compartment.

10. A cartridge according to any one of claims 1 - 9 further including wedging means coupled to the first compartment to wedge between an outer peripheral surface of the first compartment and the side wall of the hole to form a seal in the hole.

11. A cartridge according to claim 10 wherein said wedging means includes a wedging cap that fits over said a free end of the first compartment, the cap having a tapered skirt that increases in thickness in a direction away from the second compartment.

12. A cartridge according to claim 11 wherein a free end of the first compartment is provided with an end cap having a tapered external surface for mating with and assist in outward spreading of said wedging cap when said wedging cap is pushed onto said end cap.

13. A cartridge according to any one of claims 1 - 12 further including a passage passing through the first compartment to provide communication between the second compartment and a location remote from the cartridge.

14. A cartridge according to claim 13 further including an initiator disposed in the second compartment for initiating the energetic material.

15. A cartridge according to claim 14 further including an initiator cord or lead passing through the passage and connected at one end to the initiator and having a free opposite end for connection to an initiation source.

16. A cartridge according to any one of claims 1 - 15 wherein said first compartment is constructed to deform when a compressive force is applied to an upper end of the cartridge when in a hole to press said first compartment and/or stemming material into contact with the wall of the hole.

17. A cartridge according to claim 16 wherein the first compartment is made from a thin walled material.

18. A cartridge according to claim 16 or 17 wherein the first compartment is provided with one or more slits or lines of weakness to facilitate deformation or bursting of said first compartment.

19. A charging system for charging a hole formed in a hard material, the system including:

a cartridge having a first compartment holding a volume of energy absorbing stemming material and a second compartment holding a volume of energetic material; and

a stemming bar having a lower end engaging the cartridge when in the hole and an upper end adjacent or extending from the hole.

20. A system according to claim 19 further including a coupling means for coupling the stemmed cartridge to the lower end of the stemming bar.

21. A system according to claim 20 wherein the coupling means includes a recess of a shape complimentary to the shape of the lower end of the stemming bar for receiving the lower end of the stemming bar.

22. A system according to claim 21 further including an initiator disposed in the second compartment for initiating the energetic material.

23. A system according to claim 22 wherein the stemming bar is provided with a slot, recess or channel and the system further includes an initiator cord passing through said slot, recess or channel, said cord coupled at one end to said initiator and at an opposite end to an initiation source.

24. A method of charging a hole including the steps of:

providing a cartridge having a first compartment holding a volume of stemming material and a second compartment holding a volume of energetic material;

inserting the cartridge, with the second compartment first, into a hole formed in a hard material to be fractured; and

inserting a stemming bar into the hole with a lower end of the stemming bar bearing on said cartridge.

25. A method according to claim 24 further including the step of coupling the cartridge to the lower end of the stemming bar and inserting the stemming bar, lower end first, into the hole.

26. A method according to claim 25 further including the step of mechanically holding the stemming bar in the hole.

27. A method according to claim 26 further including the step of applying a compressive force to the first compartment to radially expand the first compartment into contact with a peripheral surface of the hole.

28. A method according to claim 27 wherein the step of applying a compressive force comprises applying a force to the upper end of the stemming bar which force is transmitted by the stemming bar to the first compartment.

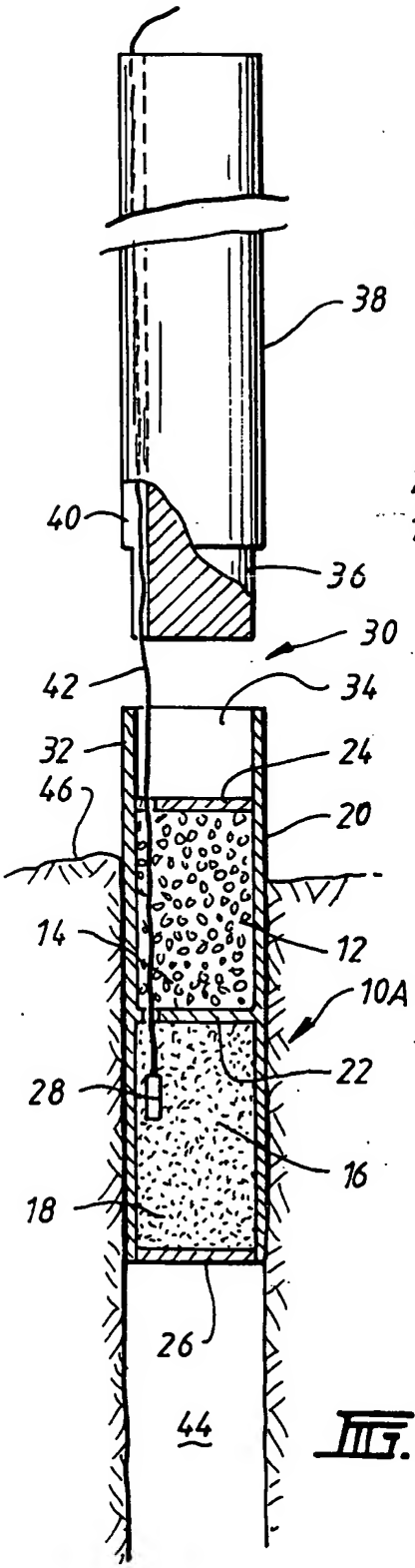


FIG. 2.

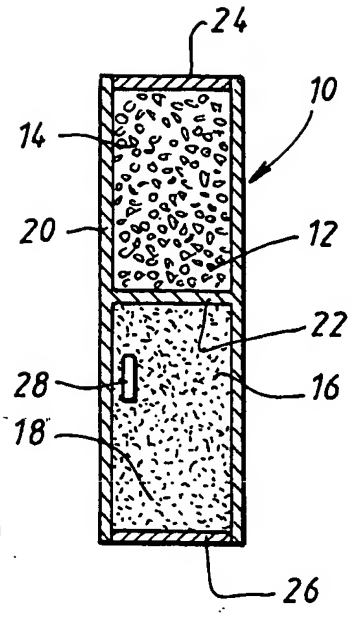


FIG. 1.

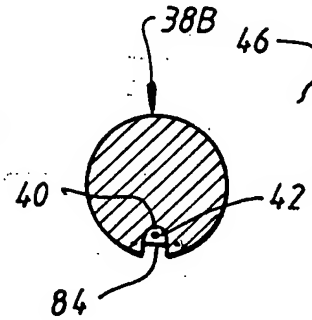


FIG. 10.

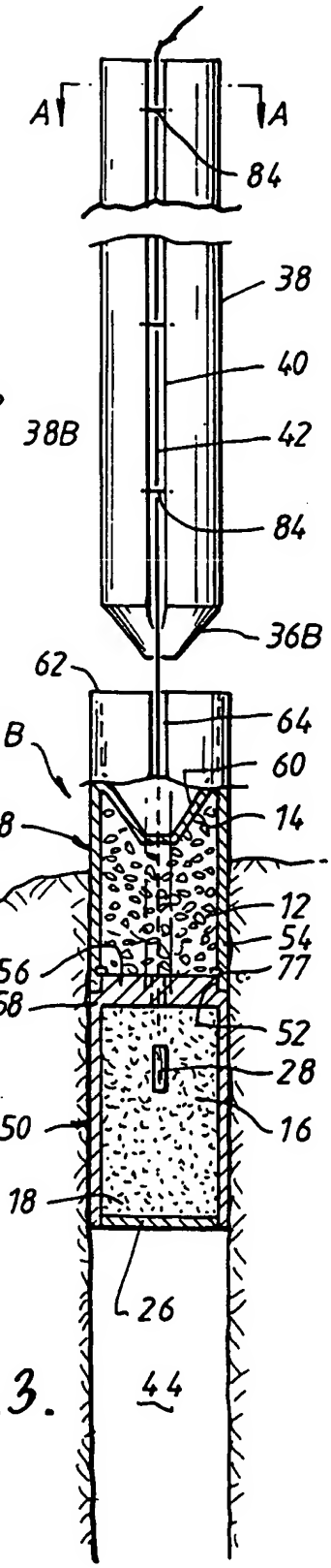


FIG. 3.

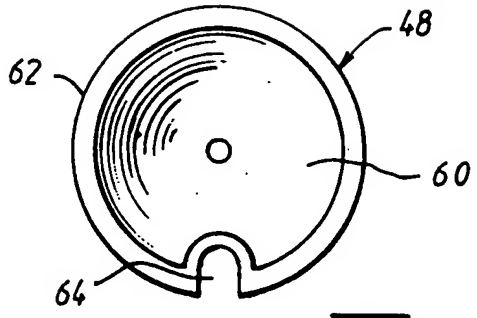


FIG. 4.

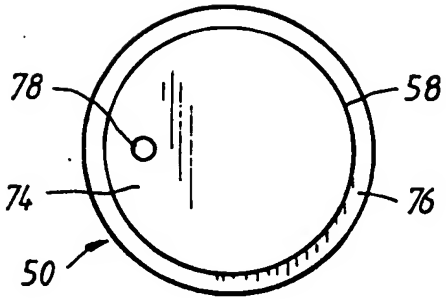


FIG. 7.

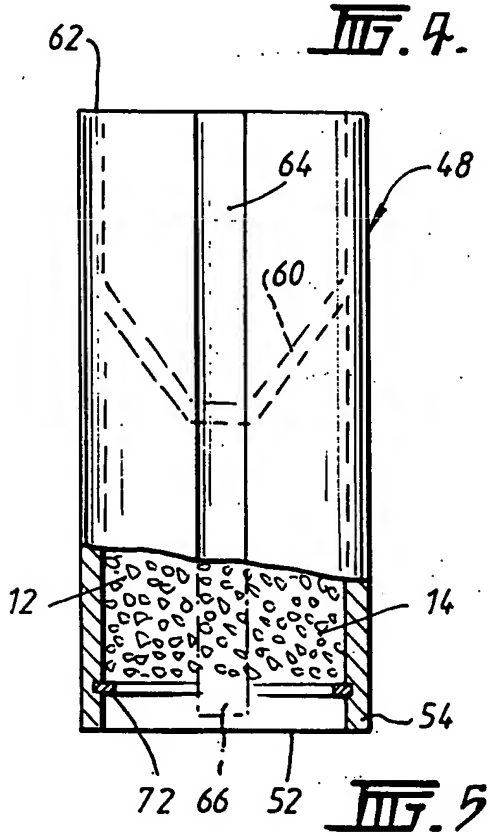


FIG. 5.

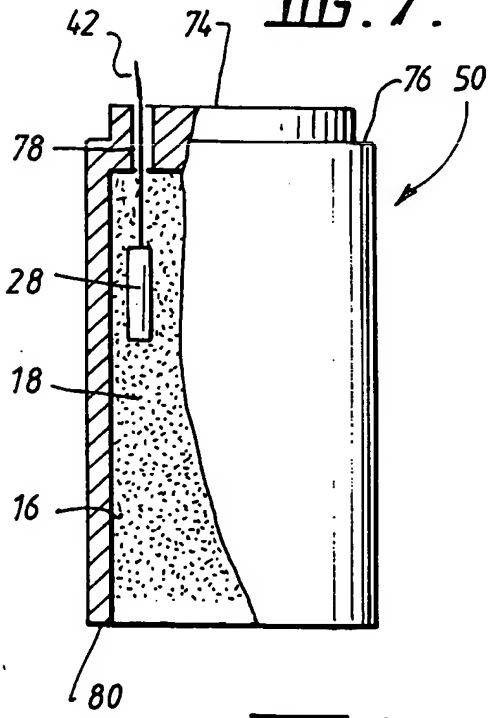


FIG. 8.

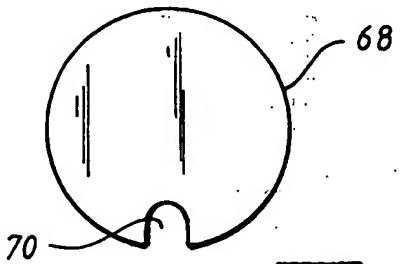


FIG. 6.

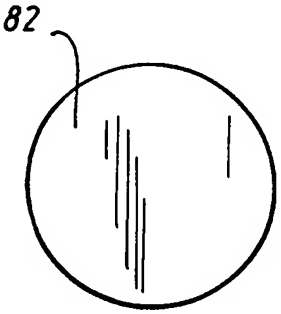


FIG. 9.

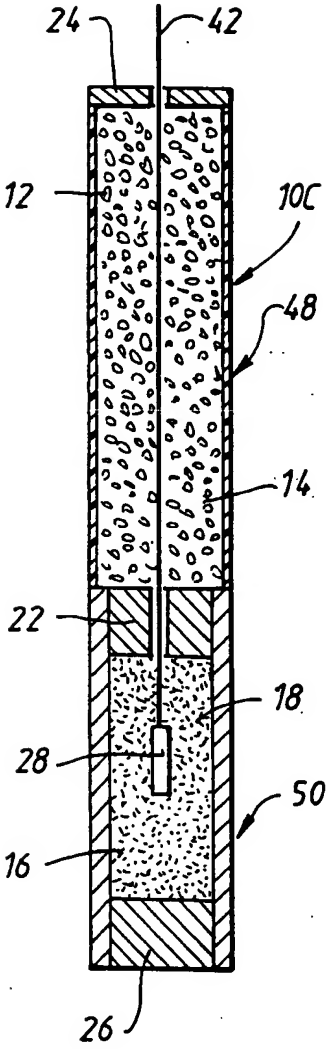


FIG. 11.

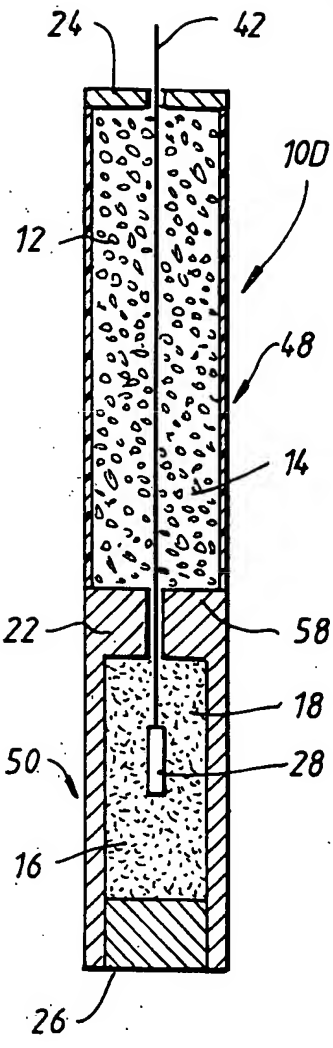


FIG. 12.

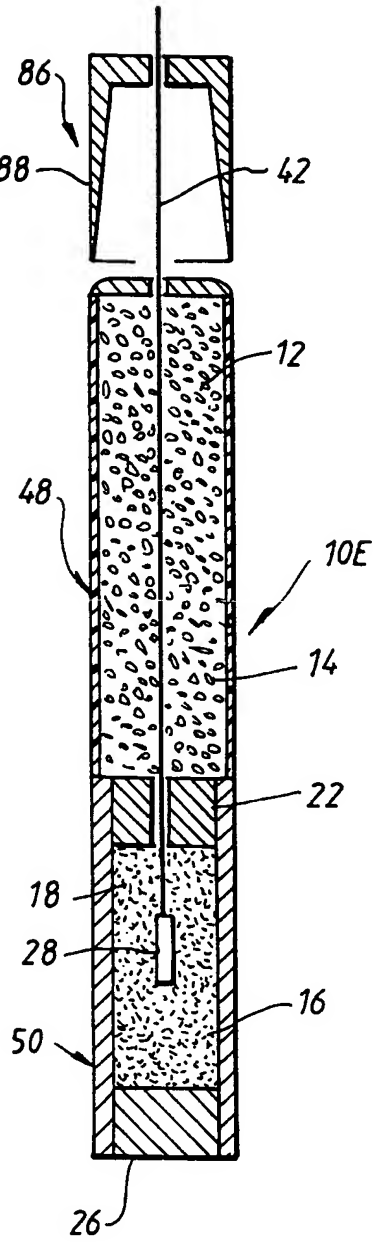


FIG. 13.

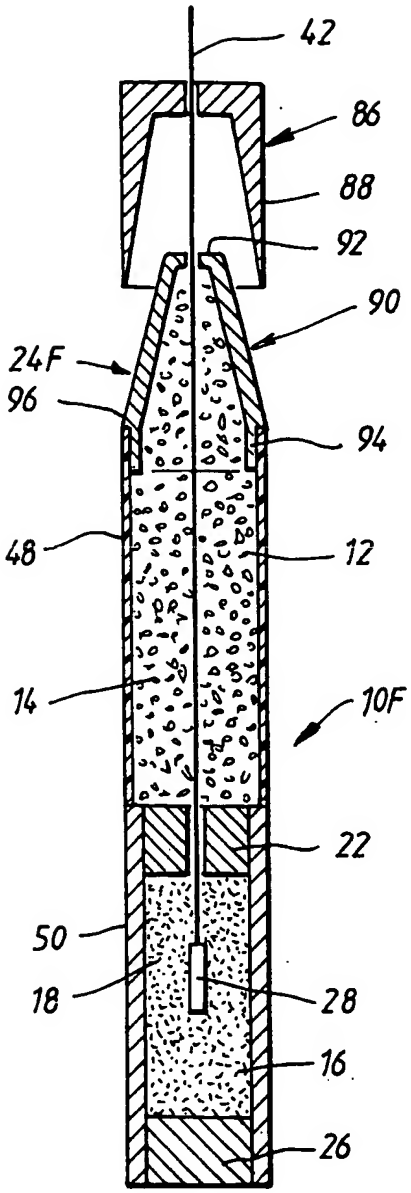

42
86
88
92
90
24F
96
94
48
12
14
10F
22
50
18
28
16
26

FIG. 14.

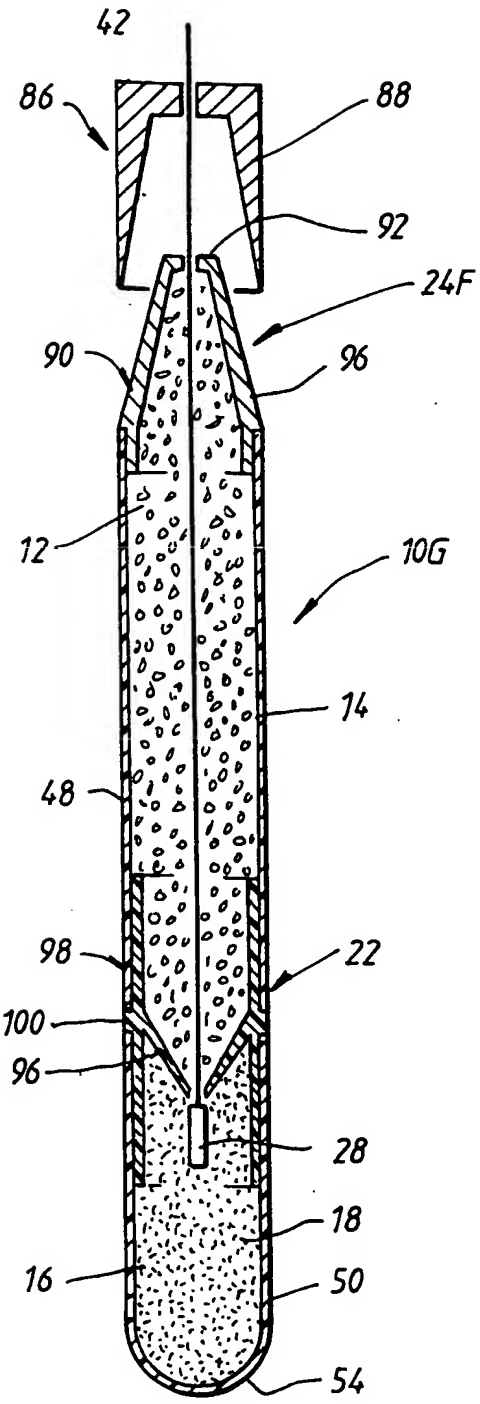

42
86
88
92
24F
90
96
12
10G
14
48
98
22
100
96
28
18
16
50
54

FIG. 15.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00265

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: F42B 3/22, 3/087; F42D 1/20, 1/22, 3/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: F42B 3/02, 3/087, 3/22, 3/26; F42D 1/02, 1/08, 1/20, 1/22, 3/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI with keywords

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	AU 14116/97 A (DENEL (PROPRIETARY) LIMITED) 27 June 1997 Figures 2-10 Whole document	1-18 19-28
Y	AU 73933/94 A (SUNBURST EXCAVATION, INC.) 10 November 1995 Whole document	19-28
A	AU 4519/37 (104790) B (IMPERIAL CHEMICAL INDUSTRIES OF AUSTRALIA & NEW ZEALAND LTD.) 25 August 1938	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 April 2000	14 APR 2000
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer JEFFREY CARL Telephone No : (02) 6283 2543

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00265

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5247886 A (WORSEY) 28 September 1993	
A	US 3837280 A (LEWER) 24 September 1974	

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU00/00265

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
AU	14116/97	CA	2239823	WO	97/21068		
AU	73933/95	AU	86107/98	US	5308149	WO	95/28551
		EP	753096				
US	3837280	BE	794363	DE	2203488	ES	410387
		FR	2169148	GB	1387330	JP	48-86701
		TR	17552	YU	3108/72	ZA	7300309

END OF ANNEX